Fresh Water Pollution; Streams; Ambient Biomonitoring Network and Fish Index of Biotic Integrity Network

Ambient Biomonitoring Network

Background

The federal Clean Water Act requires New Jersey to determine every two years whether New Jersey's waters meet the objectives of the Act, attain state water-quality standards and provide for the protection and propagation of balanced populations of fish, shellfish and wildlife. Furthermore, the state is required to assess and report on the extent to which pollution-control programs have improved water quality.

Historically, the health of aquatic systems has been monitored primarily through chemical means. However, chemical monitoring provides only a "snapshot" of conditions at the time of sampling and may fail to detect acute pollution events, such as runoff from heavy rain; non-chemical pollution, such as habitat alteration; and nonpoint source pollution.

Because of the limitations of chemical monitoring, DEP supplements it with biological monitoring. In 1996, the DEP established a statewide Ambient Biological Monitoring Network (AMNET) to collect and assess benthic macroinvertebrate populations (insects, worms, mollusks, and other indicator species) in the state's freshwater streams. The network consists of approximately 800 stations distributed equally throughout the state's five water regions (Atlantic, Raritan, Lower Delaware, Upper Delaware and Northeast regions). Stations are sampled every five years in each region on a rotating basis. Procedures for field sampling, sorting, and identification of benthic macroinvertebrates, and determination of the degree of impairment, follow detailed protocols that[1] must be carefully followed to provide consistent data. The primary goal of AMNET is to provide a long-term, cost-efficient means of gauging the quality of surface waters and watershed areas throughout the state. The data generated by AMNET is used in the DEP's preparation of water quality and impaired waterbodies reports required by the Clean Water Act.[2] The information also is used to help determine the waterbodies that should be given Category One protection. The Category One designation provides special protections for high-quality waters to protect against degradation.
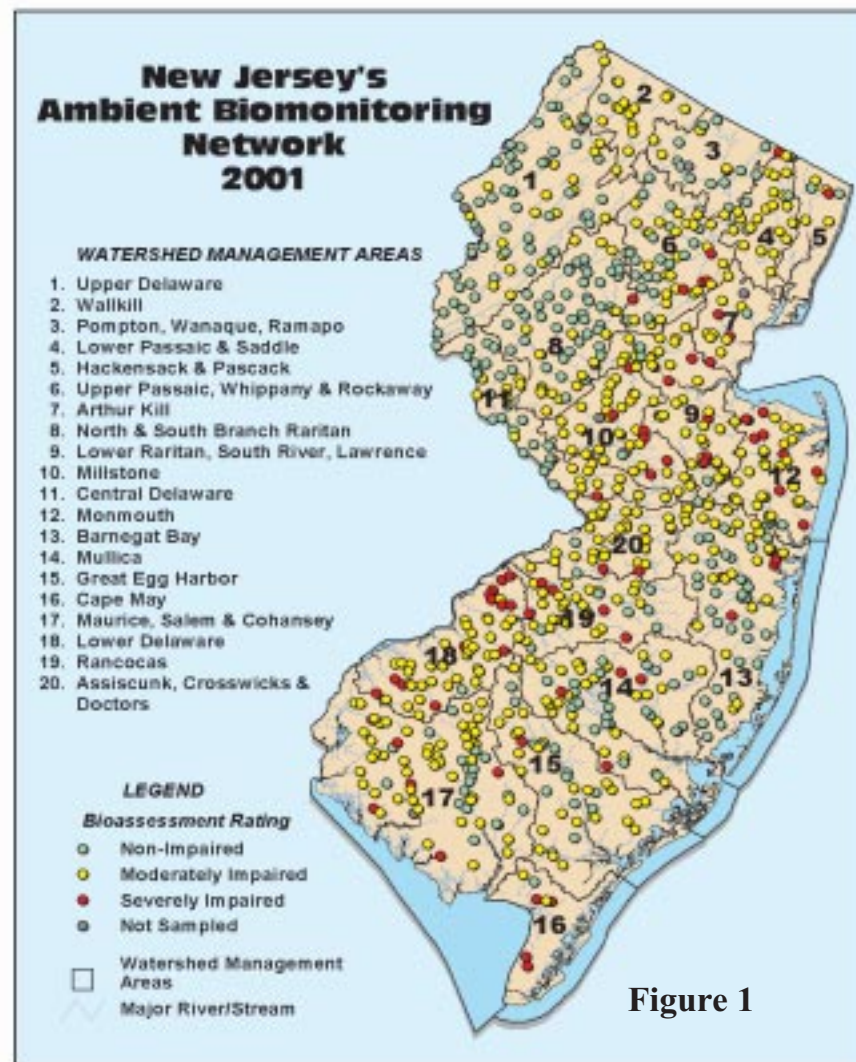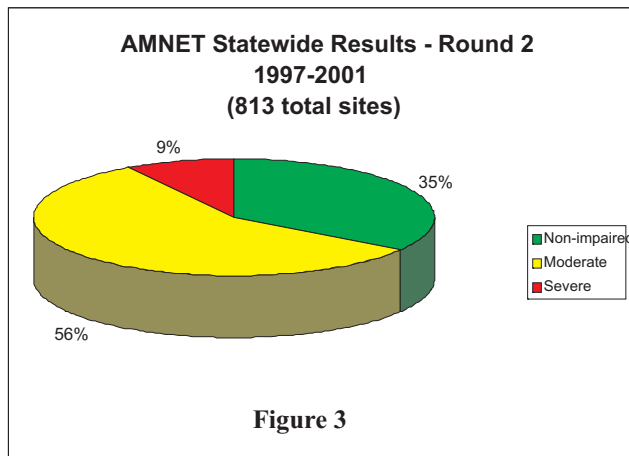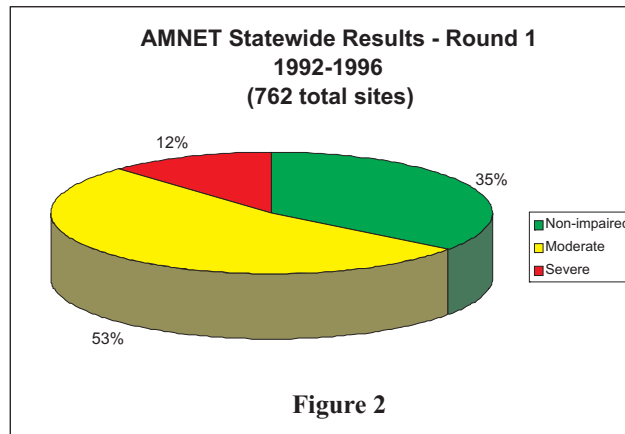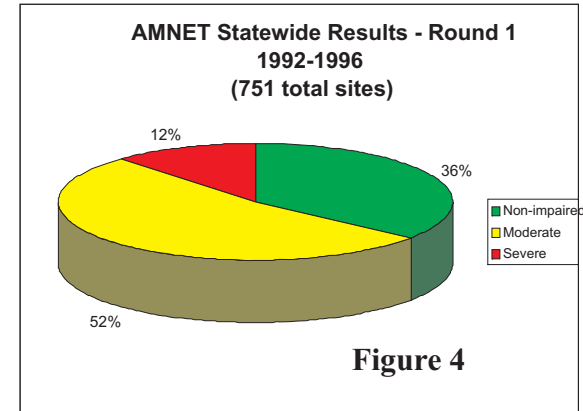

Figure 1

Trends

In 1996, the first round of statewide AMNET sampling was completed with 762 stations each sampled once. The results showed that, statewide, approximately 35 percent of the waters were non-impaired, approximately 53 percent were moderately impaired and approximately 12 percent were severely impaired. (See Figure 2)

In 2001, the second round of statewide AMNET sampling was completed with 813 stations sampled, 751 of which were sampled for the second time. The results showed that, statewide, approximately 35 percent of the waters were non-impaired, approximately 56 percent were moderately impaired and approximately 9 percent were severely impaired. (See Figure 3)

AMNET Statewide Results - Round 1
1992-1996
(762 total sites)

12%

35%

53%

Non-impaired
Moderate
Severe

Figure 2

AMNET Statewide Results - Round 2
1997-2001
(813 total sites)

9%

35%

56%

Non-impaired
Moderate
Severe

Figure 3

4). Of those same 751 sites sampled in the second round, approximately 35 percent were non-impaired, 57 percent were moderately impaired and 8 percent were severely impaired (see Figure 5).

Further investigation is necessary to determine why a site's biological assessment has declined or improved, and if these changes are related to water quality or to events such as droughts and floods.

AMNET Statewide Results - Round 1
1992-1996
(751 total sites)

12%

36%

52%

Non-impaired
Moderate
Severe

Figure 4

Of the 751 sites sampled in the first round, approximately 36 percent were non-impaired, 52 percent were moderately impaired and 12 percent were severely impaired (see Figure

There were 192 sites sampled that have shown a significant change in biological assessment. Of those 192 sites, 114 have shown a positive change and 78 have shown a negative change. Six sites showed a dramatic change from severely impaired to non-impaired. The reason for this dramatic change is not fully understood and site-specific studies should be performed. None of the sites sampled went from a non-impaired to a severely impaired rating.
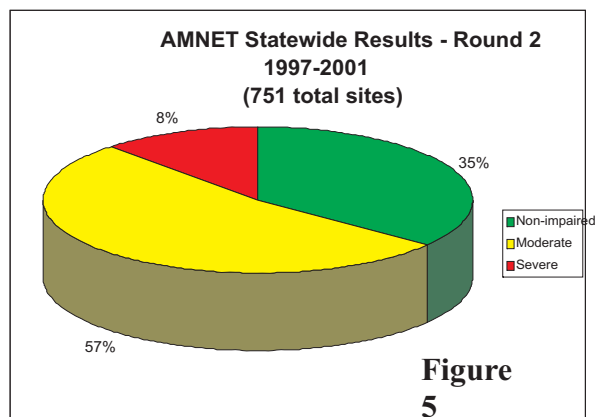
Outlook and Implications

The AMNET data show a correlation between benthic macroinvertebrate community impairment and different physiographic land types, land uses and other anthropogenic factors.[3] Recent data analysis[4] concludes the following:
1) Fish and invertebrate communities are commonly impaired in urban streams;
2) Invertebrate community impairment was related to total urban land and total wastewater flow upstream of a site;
3) Changes in aquatic community structure were statistically related to environmental variables. For example, an increase in impervious

surfaces was related to a negative response in the aquatic invertebrate community. Conversely, the same data analysis also demonstrated that the more forests and wetlands in a stream's drainage basin, the more protection there is for invertebrate community health.

Given the expectations of population growth in New Jersey (an estimated 900,000 more residents by the year 2020) land use changes may have a measurable effect on water quality and aquatic communities.

The AMNET network will continue to monitor the effects of that population growth on the aquatic biota of the state's waterways, and provide a measure of success for sound land use practices and mitigation efforts.
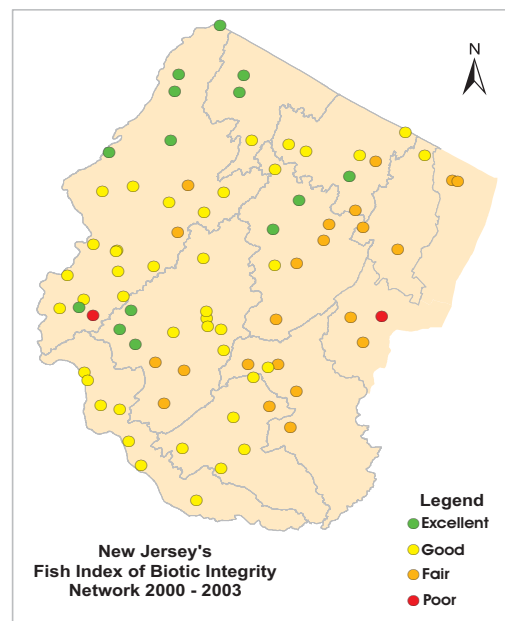

AMNET Statewide Results - Round 2
1997-2001
(751 total sites)

8%

35%

57%

Non-impaired
Moderate
Severe

Figure 5

Fish Index of Biotic Integrity Network

Background

As discussed above, monitoring of benthic macroinvertebrate populations is widely practiced in New Jersey. However, these species generally are reflective of short-term and local impairment. To assess environmental conditions on a larger scale, in summer 2000 BFBM began to use a fish index of biotic integrity (FIBI) to monitor New Jersey's streams. A FIBI measures the health of a stream based on multiple attributes of the resident fish such as species type and number and the presence of diseases. Each site sampled is then scored based on its deviation from reference conditions (i.e., what would be found in an un-impacted stream) and classified as "poor", "fair", "good" or "excellent". In addition, habitat is evaluated at each site and classified as "poor", "marginal", "suboptimal" or "optimal".

Primary objectives of the fish collections are to obtain samples with representative species and abundances, at a reasonable level of effort. Using similar stream lengths, collection methods and habitat types standardizes sampling efforts. Stream segments selected for sampling must have a minimum of one riffle, run and pool sequence to be considered representative.

New Jersey's Fish Index of Biotic Integrity Network 2000 - 2003

Legend
- Excellent
- Good
- Fair
- Poor

Status and Trends

The data provided by FIBI is becoming another component of the DEP's suite of environmental indicators and will help measure water-quality use attainment and the DEP's success in attaining the Clean Water Act goal of "fishable" waters. FIBI data also will be used to develop biological criteria, prioritize sites for further studies, provide biological impact assessments, and assess status and trends of the state's freshwater fish assemblages. Currently, FIBI data collected from northern New Jersey i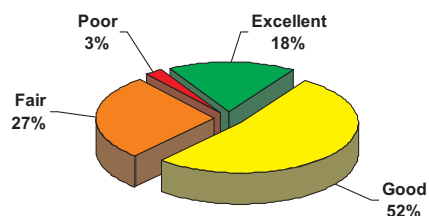s used in part to nominate candidate waters for upgrade to a Category One antidegradation classification based on exceptional ecological significance.

From 2000-2003, BFBM sampled 80 FIBI sites in the northern portion of the state covering the Counties of Sussex, Warren, Hunterdon, Passaic, Bergen, Union, Essex, Mercer, Middlesex, and Somerset. The ratings for these sites are as follows:

Outlook and Implications

By the end of summer 2004, the FIBI network had established 100 sampling stations in northern New Jersey, which will be visited once every five years as part of the BFBM's stream-monitoring efforts. Data are currently being collected for the planned expansion of the network to include both portions of southern New Jersey and the state's headwater streams, with the goal of having a state-wide network of at least 200 stations by the end of calendar year 2010.

2000 - 2003 FIBI Results
(80 total sites)

Poor 3%
Excellent 18%
Fair 27%
Good 52%

References

[1] See http://www.state.nj.us/dep/wmm/bfbm/rbpinfo.html .

[2] New Jersey Department of Environmental Protection. 2004. New Jersey 2004 integrated water quality monitoring and assessment report, 305 (b) and 303 (d). Water Monitoring and Standards. Trenton, NJ..

[3] U.S. Geological Survey. 1998. Relation of benthic macroinvertebrate community impairment to basin characteristics in New Jersey streams. Fact Sheet FS-057-98. USGS. West Trenton, NJ

[4] Ayers, M., Kennon, J., Stackleberg, P., Kauffman, L. 2000. Building a stronger scientific basis for landuse planning and watershed management effects on water quality and aquatic communities in NJ streams. USGS. West Trenton, NJ

More Information

All available AMNET reports can be obtained from the Bureau of Freshwater & Biological Monitoring by calling (609) 292-0427 or visiting www.state.nj.us/wmm/bfbm.

Reports and data for the first three years (2000-2002) of the FIBI can be obtained by visiting www.state.nj.us/dep/wmm/bfbm or by calling (609) 292-0427. Reports and data for the 2003 sites currently are being prepared and will be posted at www.state.nj.us/dep/wmm/bfbm once the report is completed.